How MREs Work

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1999 Military Photographer of the Year winner, "Combat Cuisine".
PHOTO COURTESY U.S. DEPARTMENT OF DEFENSE

The saying, "An army travels on its stomach" is one of those brilliant, concise statements of fact that sums up the nature of the universe. Without food, any human being is an unhappy animal. A soldier is a human on the move and under a lot of stress, so food is vitally important to performance and survival.

Food is the human body's source of fuel. Food also provides the building blocks for the body's natural repair and maintenance processes. And there is also a very strong psychological component to food. Bad food, even if it is nutritious, does not satisfy people, and in many cases people will not eat it. Otherwise we would all be happy eating dry kibble like dogs do. Tasty, healthy, nutritious food is essential to human happiness.

Given these facts, it is not surprising that the U.S. military spends an inordinate amount of time and effort supplying food to its troops. Food for the soldiers is just as essential as fuel for the vehicles and ammunition for the weapons.

Right on the packaging, military meals state that, "Restriction of food and nutrients leads to rapid weight loss, which leads to: Loss of strength, Decreased endurance, Loss of motivation, Decreased mental alertness." Obviously food is extremely important to human performance.

In this edition of **How Stuff Works** you will have the chance to learn about the MRE, or **Meal, Ready to Eat** -- the portable meals that soldiers eat in battle. There is a lot more to feeding a soldier than you would think!

MORE MILITARY INFORMATION

For much more information on the U.S. military and Operation Iraqi Freedom, check out the HowStuffWorks Technology of War section when you finish this article.

What's Inside?

Contents of an MRE bag

Imagine that you are a soldier on the battlefield. You are far from a mess tent with its portable kitchen, so you pull an MRE out of your backpack or your vehicle. You might, for example, pull out a "Chicken in Thai Style Sauce" meal. The entire meal is packaged in a heavy plastic bag. Inside the bag, you find:

- One box measuring 8-1/4" by 4-3/4" by 3/4" inches labeled "Chicken in Thai Style Sauce". Inside the box is a flexible pouch containing an 8-ounce (227 gram) serving of chicken and sauce. This is the entrée.

CHICKEN IN THAI STYLE SAUCE
INGREDIENTS: WATER, CHICKEN, MUSHROOMS, FOOD STARCH - MODIFIED, PEANUT OIL, BROWN SUGAR, DEHYDRATED ONION, HOT SAUCE (AGED RED CAYENNE PEPPERS, VINEGAR, SALT, AND GARLIC), DEHYDRATED CELERY, VINEGAR, SOY SAUCE (WATER, SOY SAUCE (WATER, SALT, HYDROLYZED SOY AND CORN PROTEIN, CORN SYRUP, CARAMEL COLOR), SALT, CORN SYRUP, CARAMEL COLOR, CITRIC ACID, SODIUM BENZOATE AND POTASSIUM SORBATE AS PRESERVATIVES), DEHYDRATED RED BELL PEPPERS, SALT

- One box measuring 7-1/2" by 4-3/4" by 3/4" inches labeled "Yellow and Wild Rice Pilaf". Inside the box is a flexible pouch containing a 5-ounce (142 gram) serving of rice.
- One flameless heater (see next section).
- One 1.4 ounce (40 gram) foil package of crackers.
- One 1.3 ounce (37 gram) Nutra Fruit cereal bar.
- One packet of spiced cider drink mix
- One packet of instant coffee
- One packet sugar
- One packet salt
- One packet pepper
- One packet grape jelly
- One piece chewing gum
- One moist towelette
- One pack matches
- One packet toilet paper
- One plastic spoon

All together, this meal contains 210 calories for the chicken, 160 calories for the rice, 180 calories for the crackers, 130 calories for the cereal bar and 140 calories for the drink, jelly, etc., for a total of 820 calories for the meal.

NUTRITION FACTS
SERVING SIZE 1 POUCH (227G)
AMOUNT PER SERVING
CALORIES 210 CALORIES FROM FAT 50
% DAILY VALUE*
TOTAL FAT 6G 9%
SATURATED FAT 1G 5%
CHOLESTEROL 60MG 20%
SODIUM 640MG 27%
TOTAL CARBOHYDRATE 16G 5%
DIETARY FIBER LESS THAN 1G 4%
SUGARS 5G
PROTEIN 2G
VITAMIN A 6% VITAMIN C 6%
CALCIUM 4% IRON 10%
*PERCENT DAILY VALUES ARE BASED ON A 2,000 CALORIE DIET
DISTRIBUTED BY:
AMERIQUAL FOODS
EVANSVILLE, IN 47725
INSPECTED FOR WHOLESOMENESS BY U.S. DEPARTMENT OF AGRICULTURE
NET WT. 8.0 OZ.
(227 GRAMS)

THE MENU

MREs are currently available in 24 different varieties:

1. "Beefsteak w/Mushrooms and Western Beans"
2. "Pork Rib and Clam Chowder"
3. "Beef Ravioli and Potato Sticks"
4. "Country Captain Chicken and Buttered Noodles"
5. "Chicken Breast and Minestrone Stew"
6. "Chicken w/Thai Sauce and Yellow/Wild Rice Pilaf"
7. "Chicken w/Salsa and Mexican Rice"
8. "Beef Patty and Nacho Cheese Pretzels"
9. "Beef Stew"
10. "Chili and Macaroni"
11. "Pasta w/Vegetables in Tomato Sauce"
12. "Black Bean & Rice Burrito"
13. "Cheese Tortellini"
14. "Manicotti w/Vegetables"
15. "Beef Enchiladas"
16. "Chicken w/Noodles"
17. "Beef Teriyaki"
18. "Turkey Breast w/Gravy & Potatoes"
19. "Roast Beef"
20. "Spaghetti w/Meat Sauce"
21. "Chicken Tetrazzini"
22. "Jambalaya"
23. "Chicken w/Cavatelli"
24. "Meat Loaf w/Gravy"

How Does It Taste?

A Security Police student with an MRE.
PHOTO COURTESY U.S. DEPARTMENT OF DEFENSE

The obvious question when you're talking about food is "How does it taste?" An MRE basically tastes like any sort of food out of a can does. For example, if you have had Chef Boy-R-Dee spaghetti out of a can, that is about what the MRE version of spaghetti in meat sauce tastes like.

The Thai chicken tastes like chop suey out of a can. It has a lot of chicken, along with mushrooms, celery and red pepper in a sauce that is slightly sweet (in the same way that sweet and sour chicken sauce at a Chinese restaurant tastes sweet, although this sauce is not that strong, nor is it pink). The amount of salt is completely normal for American cuisine -- it is not overpowering, but there is enough to avoid blandness. The rice that comes with the chicken is a mixture of white rice, a little wild rice, peas and carrots and a bit of sauce. It tastes a bit dry if eaten by itself, but mixed with the chicken it is fine.

Prepared "Chicken in Thai Style Sauce"

The crackers are interesting in that they are completely intact when you unwrap them. They look, taste and chew like normal saltine crackers with slightly less salt than a normal saltine.

The cereal bar tastes like any cereal bar -- it is a normal, commercial product.

A Marine adds Tabasco sauce to flavor a breakfast MRE
PHOTO COURTESY U.S. DEPARTMENT OF DEFENSE

In other words, if you grew up like a lot of Americans, eating casseroles, Hamburger Helper and lots of prepared foods out of a can or a jar, then an MRE is a completely normal, completely acceptable meal for you. If, on the other hand, you are the sort of person who prefers a salad of mixed greens with essence of cranberries effused in a vinaigrette dressing, along with a filet topped with a caramelized red onion glaze, baby carrots and angel hair pasta on the side, finishing with a strawberry sorbet and mixed fresh berries for dessert, then the MRE menu is unlikely to suit you. Of course, given all that, it is unlikely that you will enjoy any part of the military experience...

Packaging

The MRE package is officially known as a **tri-laminate retort pouch**. The pouch is essentially a flexible can made out of thick aluminum foil and plastic layers.

Canning is an extremely common food preservation technology that has been in wide use for over a century. The basic idea behind canning, either in steel cans or in flexible pouches, is very simple. You boil the food in the can to kill all the bacteria and then seal the can (either before or while the food is boiling) to prevent any new bacteria from getting in. Since the food in the can is completely sterile, it does not spoil. Once you open the can, bacteria enter and begin attacking the food. This is why you have to "refrigerate the contents after opening" (you see that label on all sorts of food products -- it means that the contents are sterile until you open the container). See How Food Preservation Works for details on a wide variety of food preservation technologies.

We generally think of "cans" as being metal, but any sealable container can serve as a can. Glass jars, for example, can be boiled and sealed. Most people prefer refrigeration or freezing to canning because the act of boiling food in a can generally changes its taste and texture (as well as its nutritional content).

The pouch used to store an MRE is a sealable container. The pouch has three big advantages over a cylindrical metal can:

- It is lighter.
- It is flexible, meaning that it can handle more abuse in the field.
- It is flat, making it easier to carry in a backpack or pocket.

The flat shape also gives the pouch an advantage during processing. In the factory, the MRE pouch is filled with food, sealed and then boiled to sterilize the contents. Because an MRE pouch is flat, it takes much less time to heat the contents to the point of sterilization. That often means a better tasting product.

This article explains how StarKist's use of retort pouches to package tuna proved to be a great time saver. Michael Mullen, a Starkist executive, points out that the "most important advantage is that the product in the pouch is of a higher quality and better tasting [than tuna in the can] because of the process. With the [flat] pouch, we only have to retort it for 45 minutes, versus four hours in a can, to kill off bacteria." That makes a big difference both to the cost of production and the quality of the food.

Starkist's tuna retort pouch

Like normal canned foods, MRE meals have a finite shelf life. The shelf life is highly dependent on the storage temperature. For example, if stored at 100 degrees F (par for the course in a desert encampment tent), an MRE is only viable for a few months. Stored at room temperature, MREs last three years. Refrigerating an MRE could extend its life for many years.

Flameless Heaters

Heating an MRE on a field stove
PHOTO COURTESY U.S. DEPARTMENT OF DEFENSE

Most human beings much prefer a warm meal to a cold one, especially if they're in cold or wet conditions. Eating cold spaghetti or cold beef stew is definitely no fun. A hot meal, on the other hand, can lift a soldier's spirits.

Because of the importance of a hot meal, all military MREs come packaged with a **flameless heater**. The flameless heater uses a simple chemical reaction to provide sufficient heat to warm the food.

A Marine demonstrates a flameless heater.
PHOTO COURTESY U.S. DEPARTMENT OF DEFENSE

Chemical heating is actually a pretty widespread natural phenomenon. Everyone has seen iron rust. Rust is a natural process in which iron atoms combine with oxygen atoms to create reddish, crumbly iron oxide. The process is normally very slow, but we all know that wet iron rusts faster. Iron exposed to salty ocean water rusts the fastest.

When iron turns to rust, the oxidation process generates heat. But rust forms so slowly that the heat generated is unnoticeable. We are all familiar with much faster oxidation reactions as well. For example, when you "oxidize" the carbon atoms in a charcoal briquette, they get quite hot. We use the word **burning** to describe this high-speed sort of oxidation.

The idea behind a flameless heater is to use the oxidation of a metal to generate heat. Magnesium metal works better than iron because it rusts much more quickly. To make a flameless heater, magnesium dust is mixed with salt and a little iron dust in a thin, flexible pad about the size of a playing card. To activate the heater, a soldier adds a little water. Within seconds the flameless heater reaches the boiling point and is bubbling and steaming. To heat the meal, the soldier simply inserts the heater and the MRE pouch back in the box that the pouch came in. Ten minutes later, dinner is served!

Chemistry Tricks
M&Ms are an example of a food product designed around the rigors of military life. The M&Ms history page describes the birth of M&Ms this way:

> Who would have guessed that the idea for "M&M's"® Plain Chocolate Candies was born in the backdrop of the Spanish Civil War? Legend has it that on a trip to Spain, Forrest Mars Sr. encountered soldiers who were eating pellets of chocolate that were encased in a hard sugary coating to prevent them from melting. Inspired by this idea, Mr. Mars went back to his kitchen and invented the recipe for "M&M's"® Plain Chocolate Candies.
>
> First sold to the public in 1941, "M&M's"® Plain Chocolate Candies became a favorite of American GIs serving in World War II. Packaged in cardboard tubes, "M&M's"® Plain Chocolate Candies were sold to the military as a convenient snack that traveled well in any climate. By the late 1940's, they became widely available to the public, who gave them an excellent reception.

Food scientists are constantly looking for ways to make prepared foods last longer, work in different climates, or taste and feel better.

For example, during the Gulf War, food engineers found a way to make chocolate bars that do not melt in desert heat like normal chocolate bars do. The technique involves emulsifiers that separate the fat in the chocolate so that, even when melted, it can not flow together to melt the bar. The chocolate does not liquefy in high heat, but it still "feels" like chocolate (rather than plastic) when you chew it. Hershey released it's version of the chocolate to the general public as *Desert Bars* during the first Gulf war.

Another recent triumph has been bread that does not disintegrate and does not go stale even after years on the shelf. It looks, tastes and feels like normal bread, and can even be used to make things like PB&J sandwiches, but it lasts far longer than normal bread does. It is called *pouch bread* because it comes sealed in a protective tri-laminate pouch like MREs do.

This article hints at some of the experiments that food engineers conducted while perfecting shelf-stable bread products for the military:

> The reduction of sucrose ester (SE) [because of price] and the addition of sodium stearoyl lactylate (SSL) in pouch bread were evaluated. Water activity (Aw), pH and microbiological analysis were conducted to ensure specifications were met. Parameters such as specific volume, peak-force, L-value, and sensory were measured before during and after storage. Measured parameters indicated any changes in volume, texture, crumb color, acceptability, and relative chemical stability of the proposed emulsifier system.
>
> A significant synergistic effect of two emulsifiers was shown. Replacing half of the SE with 0.25% SSL almost reduce the peak force (hardness) in half without significant changes in specific volume and L-value. Whereas replacing 75%SE with 0.25% SSL increased the peak force by 33%. This level also affected L-values, appearance and sensory attributes.
>
> Research results show the beneficial, synergism of SE and SSL exist. The optimization of these emulsifiers, allows pouch bread to have an extended shelf life---now at a reduced cost. Maintaining low oxygen levels [with oxygen scavenging packets], controlling Aw [with emulsifiers] and using tri-laminated packaging give additional quality protection.

Researchers run extensive taste tests and extended feeding tests, both in the lab and in the field, to see which meals are best received. Meals that no one likes are eliminated. This research has turned up several interesting pieces of information:

- People like variety. The original MRE program had six entrees on the menu. Today there are 24 because people eat more when there is a lot of variety.
- "Commercial" graphics, rather than olive drab packaging, improves consumption.
- Name brand side items (candy, chips, etc.) and a variety of "accessories" with a meal improve consumption of the rest of the meal.
- People like the option of hot sauce regardless of what they are eating.

See the links at the end of the article for details on this sort of research.

A Little History

Recreations of Civil War era storage barrels, at Fort Macon State Park

Nations have been fighting wars for centuries, and the food problem has always been a big one for armies on the move. Having looked at the food eaten by modern soldiers, it is fascinating to look back and see, for example, what soldiers ate during the Civil War.

At Fort Macon State Park on the coast of North Carolina there is a restored fort that served during the Spanish-American war and then the Civil War. The storeroom and kitchen are restored versions of the facilities as they would have appeared over a century ago.

As you can see, the primary unit of storage was the barrel. Meat was salted and stored, in salt, in barrels (the salt prevented bacteria from attacking the meat and preserved it). Flour, rice, coffee, etc. were stored dry in barrels. At the fort they could bake normal loaves of bread, but in the field soldiers ate **hardtack** -- incredibly hard, square biscuits shipped in boxes. Think of how hard a dog biscuit is and you have the general feeling of hardtack.

In the photo above, you may notice barrels labeled "sour kraut" and "pickled onions", and you may find that odd. These vegetable are **anti-scorbutics** -- that is, they contain vitamin C and therefore help prevent scurvy, which is caused by a lack of vitamin C. Scurvy was a big problem for soldiers and sailors for many centuries until artificial vitamin C pills became widely available.

A recreation of Civil War era food scales, at Fort Macon State Park

A typical daily ration for a soldier stationed at Fort Macon during the civil war looked like this (source: park signage):

- **Pork or Bacon**, three fourths pound, or **Fresh or Salt Beef**, one pound four ounces.
- **Soft bread or Flour**, eighteen ounces, or **Hard Bread** (Hardtack), twelve ounces, or **Corn Meal**, one pound four ounces.
- **Beans or Peas**, 2.56 ounces, or **Rice**, 1.6 ounces, or in lieu thereof twice a week 1.5 ounces **Desiccated Potatoes** and one ounce **Desiccated Mixed Vegetables**.
- **Coffee**, 1.6 ounces, or **Tea**, 0.24 ounces.
- **Sugar**, 2.4 ounces.
- **Vinegar**, 1.28 ounces
- **Salt**, 0.64 ounces
- **Pepper**, 0.04 ounces,
- **Sperm Candles**, 0.16 ounces, or **Adamantine Candles**, 0.2 ounces, or **Tallow Candles**, 0.24 ounces.
- **Soap**, 0.64 ounces.

The *1861 Military Handbook and Soldiers Manual of Information* has recipes that the cooks used to prepare meals for soldiers eating together in the fort. For example:

> **To Cook Salt Meat for Fifty Men** - Put fifty pounds of meat in the boiler. Fill with water and *let soak all night*. Next morning wash the meat well. Fill with fresh water, and boil gently three hours and serve. Skim off the fat, which, when cold, is an excellent substitute for butter.
>
> **Soup for Fifty Men** - Put in the boiler seven and one half gallons of water. Add to it fifty pounds of meat, the rations of preserved or fresh vegetables (about eight pounds of fresh vegetables; or four squares from a cake of preserved vegetables); a table-spoonful of pepper, if handy; ten small table-spoonfuls of salt. Simmer three hours, and serve. When rice is issued put it in when boiling. Three pounds will be sufficient. Skim off the fat, which, when cold, is an excellent substitute for butter.

> **Salt Pork with Mashed Peas for One Hundred Men** - Put in two stoves fifty pounds of pork each; divide 22 pounds of peas in four pudding cloths, rather loosely tied, putting to boil at the same time as your pork; let all boil gently till done, say about two hours; take out the pudding cloth and peas; put all meat in one caldron; remove the liquor from the other pan, turning back the peas in it; add two tea-spoonfuls of pepper, a pound of fat, and with a wooden spatula smash the peas and serve both.

As you can see, military food preparation and menus have changed substantially since the Civil War.

For more information on MREs and a variety of military food topics, see the links in the following section.

Related HowStuffWorks Articles

- How Food Works
- How Food Preservation Works
- How Freeze Drying Works
- How Refrigerators Work
- How Bread Works
- The Technology of War

More Great Links

- Operational Rations
- Trickle-Down Technology
- Evolution of Rations
- Meals Ready to Eat Follow Warfighters Into the Field
- Retorted Food Pouches Ready for Market Push
- Portable Packaging
- Military and Humanitarian Rations
- The Army Family of Rations
- The Effects of Ration Modification on Energy Intake, Body Weight Change and Food Acceptance
- Look for Pepperoni and Barbecue Sandwiches in MREs Soon
- MRE History
- Mil. Spec. for assembled MREs
- Food Services Reference
- A Brief History of Army Food Service
- The Foundation of an Army is the Belly
- Hot Meals
- Stoichiometry
- Ration D Bar
- Heat Resistant Chocolate
- Patent for Making Heat-resistant Chocolate and Chocolate-like Compositions with Reduced Apparent Viscosity
- C-Rations, with nice photos
- Make your own C-Rations Instruction Kit